LUBASHEVSKAYA, L.N., dotsent

Lipoproteins in the blood serum of patients with seroresistant syphilis. Vest. derm. i ven. 38 no.1:41-44 Ja '64. (MIRA 17:8)

1. Kafedra kozhnykh i venericheskikh bolezney (zav. - prof. D.A. Trutnev [deceased]) Voronezhskogo meditsinskogo instituta.

LUBASHEVSKAYA, L.N., dotsent

C-reactive protein test in the clinic of skin diseases. Vest. derm. i ven. 38 no.4:22-27 Ap '64. (MIRA 18:4)

1. Klinika kozhnykh i venericheskikh bolezney (zav. - doktor med. nauk B.A.Zenin) Voronezhskogo meditsinskogo instituta (dir. - prof. N.I.Odnoralov).

LUBASHEVSKIY, N.I.

Thoracoabdominal transpleural approach in surgery in splenomegaly. Probl. gemat. i perel.krovi 5 no.1:32-36 Ja '60. (MIRA 14:6)

1. Iz kafedry gospital'noy khirurgii (zav. - deystvitel'nyy chlen AMN SSSR prof. B.V.Petrovskiy) I Moskovskogo ordena Lenina meditsinskogo instituta imeni I.M.Sechenova.
(SPLEEN--SURGERY)

LUBASHEVSKIY, N.I. (Moskva, Zubovskiy bul'var, d.37,komn.52)

Thoracoabdominal transpleural appraoch in splenomegalia. Grud. khir. 1 no.5:99-102 S-O '61. (MIRA 15:3)

1. Iz kafedry gospital'noy khirurgii (zav. - deystvitel'nyy chlen AMN SSSR, zasluzhennyy deyatel' nauki prof. B.V. Petrovskiy) I Moskovskogo ordena Lenina meditsinskogo instituta imeni I.M. Sechenova.

(SPLEEN--SURGERY)

LUBAVSKII, K.; LVOVA, E.

Non-oxydizing ceramic flux for arc welding. p. 29.

ZVARACSKY SBORNIK. (Slovenska akademie vied) Bratislava, Czechoslovakia. Vol. 8, no. 1, 1959.

Monthly list of East European Accessions (EEAI) LC, Vol. 8, no. 10, Oct. 1959. Uncl.

LUBAVSKIY, V.I., kandidat tekhnicheskikh nauk, dotsent.

Technological premises for regular flow of production in mechanical workshops producing in lots. Trudy LIEI no.6:7-31 '53. (MLRA 9:8)
(Machine-shop practice) (Industrial management)

SZUMAN, Jerzy; GORSKI, Lech; LUBAWA, Urszula

Influence of the season upon the growth rate of goose feathers. Roczniki Wyż Szkola Rol Poznan no.12:79-95 '62.

1. Zaklad Hodowli Drobiu i Zwierzat Futerkowych, Wyzsza Szkola Rolnicza, i Branzowe Laboratorium Badawcze Przemyslu Jajczarsko-Drobiarskiego, Poznan.

SZUMAN, Jerzy; DORUCHOWSKI, Wojciech; LUBAWA, Urszula

Evaluation of mashes produced by the Polish fodder industry for feeding broilers. Roczniki wyz szkola rol Poznan 17:209-224 '63.

1. Department of Specific Animal Breeding, College of Agriculture, Poznan, and Central Laboratory of the Egg and Poultry Industry, Poznan.

LUBAWSKA, Janina

H.

POLAND/Cellulose and Its Production. Paper.

Abs Jour : Ref Zhur - Khimiya, No 19, 1958, 66226

Author : Brejdygant-Miroslawska Maria, Lubawska Janina
Inst : -
Title : Cellulose Manufactured by the Polish Industry and the Extraction from It of Acetylcellulose in Laboratory Conditions.

Orig Pub : Przegl. papiern., 1958, 14, No 3, 65-68.

Abstract : On the basis of the comparative acetylation of 3 forms of wood cellulose of the Polish industry before and after refining by cold and hot alkali according to the method of Yayme and Shemka, conclusions have been made concerning the possibility of the use of Polish cellulose for acetylation.

Card 1/1

LYSHCHENKO, A.F.

USSR

Theory of the dielectric properties of barium titanate in stationary fields. A. P. Ghantsman and A. F. Lubchenko. *Zhur. Eksptl. i Teoret. Fiz.* 23, 183-98(1952); *Science Abstr.*, 55A, 705(1952).—An approx. calcn. is made of the actual field in $BaTiO_3$ and of the susceptibility below the Curie point (T_c), on the basis of the existence of a covalent bond between the Ti ion and one of the O ions when calcg. the geometrical structure of the lattice. The qual. theory gives the dependence of ϵ on temp. for $T < T_c$ and a value of T_c. A general method of calcg. the dependence of ϵ on external field and the dependence of the spontaneous polarization on T is outlined.

K. L. C.

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(1)

LUBCHENKO, A. F.

USSR/ Physics - Spectral analysis

Card 1/1 Pub. 43 - 45/62

Authors : Lubchenko, A. F.

Title : Effect of a solvent on the absorption and luminescence spectra of molecules

Periodical : Izv. AN SSSR. Ser. fiz. 18/6, 718-720, Nov-Dec 1954

Abstract : In order to investigate the effect of a medium on the absorption and luminescence spectra of molecules the author generalized certain aspects of the quantum electrodynamics of a vacuum in anisotropic media. The electromagnetic field in the tested dielectric is described by a wave function with the idea of a secondary quantum. The wave function of the molecule + solvent + field of radiation system was determined in an adiabatic approximation. Results obtained are listed. Seven references: 4 USSR, 1 USA and 2 German (1927-1953).

Institution : Acad. of Sc., Ukr. SSR, Phys. Inst.

Submitted : .....

LUBCHENKO, A.F.

USSR / Physical Chemistry. Crystals. B-5

Abs Jour : Ref Zhur - Khimiya, No 8, 1957, 25915

Author : A.F. Lubchenko
Title : Light Absorption and Radiation by Impurities at Excitation of Their Local Vibration Levels.

Orig Pub : Ukr. fiz. zh., 1956, 1, No 3, 281-293

Abstract : The shape of light absorption and radiation bands of impurities at the excitation of their local vibration levels was investigated. It was shown that the electron vibrating bands of impurities (their changes with the temperature and solvent nature) were described with the same analytical expressions as the "electron-lattice" bands (See the foregoing abstract). A considerable overlapping of electron-vibration bands may be expected in case of large molecules (aromatic compounds, dyes), thus continuous wide bands will be observed in their absorption and radiation spectra. The temperature dependence of the shape of these bands was studied.

Card : 1/1

LUBCHENKO, A.F

USSR / Physical Chemistry. Molecules. Chemical Bond B-4

Abs Jour : Ref Zhur - Khimiya, No 8, 1957, 25769

Author : A.F. Lubchenko
Title : Light Absorption in Molecular Crystals Containing Different Molecules in Elementary Cell

Orig Pub : Optika i spektroskopiya, 1956, 1, No 7, 867-875

Abstract : The theory of light absorption by lolecular crystals, the elementary cells of which contain molecules differing by atom arrangement, but of the same chemical composition, is developed. Concrete computations were carried out for crystals, in the cells of which there aremolecules of two descriptions. It is shown that if the molecules had the same sight-symmetry and the arising of exiton states was possible, the total number of zones equal to the summary number of molecules in the cell corresponds to each nondegenerate excited term of the molecule in the crystal. The rules of selection and the polarization of split components at the absorption and combined scattering of light in stilbene crystals

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USSR / Physical Chemistry. Molecules. Chemical Bond B-4

Abs Jour : Ref Zhur - Khimiya, No 8, 1957, 25769

Abstract : are discussed as an example. It is found that four transitions in the crystal correspond to each allowed transition from the normal state into the excited one, two of these transitions are polarized along the monoclinal axis b, and the two others are perpendicular to b; each oscillation type appearing in the spectrum of combined scattering is split in the crystal in four vibrations, two of which belong to holosymmetrical oscillations and the other two of which are not holosymmetrical.

Card : 2/2

LUBCHENKO, A.F.

Category : USSR/Optics - Physical optics K-5

Abs Jour : Ref Zhur - Fizika, No 1, 1957, No 2340

Author : Lubchenko, A.F.
Title : On the Theory of Dispersion of Solutions

Orig Pub : Dopovidi AN URSR, 1956, No 3, 253-258

Abstract : The dispersion curves of impurity centers are calculated, and their variation with temperature and with the nature of the solvent is investigated; the calculations are based on the adiabatic approximation. It is shown that in the case when the absorption curves are shaped like the Gaussian error curve, the dispersion curves can be described by expressions similar to those of the dispersion curves of the free molecule with allowances for the Doppler effect. At lower temperatures, when the absorption curves becomes asymmetric, the dispersion curve also displays an asymmetry. In the case of weak bonds or at very low temperature, when the absorption spectrum breaks up into a system of lines similar to the lines of the atomic spectra, the dispersion curve corresponding to each individual absorption line is of the form $x/(1 + x^2)$.

Card : 1/1

LUBCHENKO, A.F.

USSR / Physical Chemistry. Molecule. Chemical Bond B-4

Abs Jour : Ref Zhur - Khimiya, No 8, 1957, 25770

Author : A.F. Lubchenko
Inst : Academy of Sciences of Ukrainian RSR
Title : Absorption Spectrum and Spectrum of Combined Light Scattering in Phenanthrene and Tolane Crystals.

Orig Pub : Dopovidi AN URSR, 1956, No 4, 336-340

Abstract : The theoretical-group computation of spectra of absorption and combined light scattering in phenanthrene and tolane crystals is carried out. The computation was based on the theory of A.S. Davydov (Theory of Light Absorption in Molecular Crystals, Kiev, 1951) and the x-ray-structural data (Basak B.S. Ind. J. Phys., 1951, 24, No 7; Robertson J., Woodward I., Proc. Roy. Soc., 1938, A164, 436). It was shown that two exiton zones corresponded to each excited state of the phenanthrene molecule in the crystal, and that

Card : 1/2 - 19 -

LUBCHENKO, A.F.

Category : USSR/Optics - Spectroscopy K-6

Abs Jour : Ref Zhur - Fizika, No 1, 1957 No 2425

Author : Davidov, O.S., Lubchenko, A.F.
Title : Radiation and Absorption of Light in Molecular Crystals, Owing to the Formation of Localized Excitations

Orig Pub : Ukr. fiz Zh., 1956, 1, No 1, 5-14

Abstract : A theory is developed for the radiation and absorption of light by molecular crystals when localized excitations are formed in the crystals. The wave function of the crystal + radiation-field system (neglecting the interaction between the field and the crystal) is selected to be the product of the wave function of the radiation field in the secondary-quantization representation, the antisymmetrized product products of the wave functions of the individual molecules making up the crystal, and the wave functions of the harmonic oscillators describing the oscillatory state of the crystal. The probability of the transition of the system from one quantum state into another is calculated from the equation $Wd\Omega = (2\pi/h)\rho_E |H'|^2$, where ρ_E is the density of the finite states in a single interval of energy E, H' is the matrix element of the energy of interaction between the dield and the crystal, and $d\Omega$ is the solid-angle element. Expressions are obtained for the radiation intensity I_λ^{xir} and for the absorption intensity I_λ^{xia} of light polarized along the axes of the Cauchy ellipsoid

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Inst. Physics, Acad Sci Ukr. SSR

Category : USSR/Optics - Spectroscopy K-6

Abs Jour : Ref Zhur - Fizika, No 1, 1957 No 2425

when localized excitation is produced in the crystal, a simple relationship is found between $I_{\lambda}^{x_i r}$ (or $I_{\lambda}^{x_i a}$), the indices of refraction $n_{x_i}(\nu_{\lambda})$ (i = 1, 2, 3), and the squares of the cosines of the angles that determine the orientation of the dipole moment of the transition relative to the axes x_i of the Cauchy ellipsoid. The latter makes it possible to determine the orientation of the dipolemoment of the transition relative to the axes of the molecule from the experimental values of $I_{\lambda}^{x_i a}$ or $I_{\lambda}^{x_i r}$ (for a known crystal structure).

Card : 2/2

LUBCHENKO, A. F.

Category : USSR/Optics - Spectroscopy K-6

Abs Jour : Ref Zhur - Fizika, No 1, 1957 No 2426

Author : Davidov, D.S., Lubchenko, A.F.
Title : Spectral Distribution of the Intensity of the Radation and Absorption of Light by Molecular Crystals Upon Formation of Localized Excitations.

Orig Pub : Ukr. Fiz. zh., 1956, 1, No 1, 15-28

Abstract : Calculation of the spectral distribution of the intensity in the bands of absorption (AB) and radiation (RB) of light by molecular crystals upon formation of localized excitations (LE), and also of the average radiation lifetime (τ) of the LE. The calculation is based on the Weisskopf-Wigner method (Weisskopf V., Wigner E, Z. Phys., 1930, 65, 18; 1930, 63, 54). Radiationless transitions are disregarded. It is shown that the shapes of the AB and RB of light occuring upon formation of LE in the crystal depend on the crystal temperature. At high temperatures, the AB and RB have the shape of the Gaussian error curve. At lower temperatures the bands become asymmetrical relative to the line passing through the maximum of the band perpendicular to the frequency axis; the absorption curve diminishes more rapidly in the red portion of the spectrum than in the violet one; the luminescence curve acts oppositely. At low temperatures, the AB and RB are a system of lines similar to the lines of the atomic spectra (their shape is given by the expression $1/1 + x^2$)).

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Category : USSR/Optics - Spectroscopy K-6

Abs Jour : Ref Zhur - Fizika, No 1, 1957, No 2426

Interaction with acoustic oscillations may lead to a broadening of each of the lines, so that some of the lines may overlap. The lifetime (τ) of the local excitation depends on the nature of the crystal and on the temperature; at high temperatures $1/\tau = c_1' + c_2''T$, where c_1' and c_2'' are independent of the temperature.

Card : 2/2

LUBCHENKO, A.F.

USSR/Physical Chemistry - Crystals B-5

Abs Jour : Referat Zhur - Khimiya, No 2, 1957, 3593

Author : Davydov A.S., Lubchenko A.F.
Title : Configuration of the Dispersion Curves of Molecular Crystals Corresponding to Localized Excitations

Orig Pub : Ukr. fiz. zh., 1956, 1, No 2, 111-119

Abstract : On the basis of previously obtained results (RZhKhim, 1956, 67745, 67746) were calculated the configurations of dispersion curves (DC) of molecular crystals in the region of localized excitations, at different temperatures. At high temperatures DC have a configuration analogous to that of DC of the free molecule on taking into account the Doeppler effect. On decrease of temperature DC becomes asymmetrical in relation to straight line extending through maximum of absorption band, perpendicularly to the frequency axis. At low temperatures, when the absorption spectrum separates into a system of lines,

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LUBCHENKO, A.F

Category : USSR/Optics - Spectroscopy K-6

Abs Jour : Ref Zhur - Fizika, No 1, 1957, No 2427

Author : Lubchenko, A.F.
Title : Effect of the Anisotropy of the Solvent on the Absorption and Radiation Spectra of Impurities

Orig Pub : Ukr. fiz. zh., 1956, 1, No 2, 120-133

Abstract : An attempt is made to use the disciplines of quantum electro-dynamics for an investigation of the absorption and radiation spectra of solutions. Accordingly, certain premises of quantum electrodynamics are extended to anisotropic media. The system molecule + solvent + radiation field is analyzed. The wave functions and the corresponding energy eigenvalues are determined in the adiabatic approximation, and the wave functions corresponding to the local oscillations are separated; the interaction between the admixture molecule and the radiation field is considered as a perturbation. The transition probability from one quantum state into another is calculated per unit time. The expressions obtained thereby established a simple relationship between the intensities of the radiation $K_{lp}^{x_1 r}$ and absorption $I_{lp}^{x_1 a}$ of light polarized along the Cauchy ellipsoid, the indices of refraction along these axes, and the squares of the direction cosines, determining the average orientation of the dipole moment of the transition relative to the same axes. The expressions obtained for the

Inst. Physics Acad Sci Ukr SSR

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Category : USSR/Optics - Spectroscopy K-6

Abs Jour : Ref Zhur - Fizika, No 1, 1957, No 2427

probability of the absorption and radiation of light by the impurity center are used to establish the connection between the Einstein differential coefficients also for the case when the frequencies of the radiated and absorbed light are not the same.

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LUBCHENKO, A.F.

USSR / Physical Chemistry. Crystals. B-5

Abs Jour : Ref Zhur - Khimiya, No 8, 1957, 25914

Author : A.F. Lubchenko
Title : Shape of Bands of Light Absorption and Radiation by Impurity Centers.

Orig Pub : Ukr. fiz. zh., 1956, 1, No 3, 265 - 280.

Abstract : The shape of bands of light radiation and absorption by impurity centers, corresponding to the transition of their local vibrating states without excitation, and the dependence of the shape on the temperature and nature of the solvent is investigated. It is shown that in case of great displacements of atoms of the solvent from the equilibrium positions at the transition of an impurity center from one state into another (i.e., at high temperatures) the bands have the shape of the error curve of Gauss. The bands become asymmetric with the temperature drop, the absorption curve decreasing towards the red end of the spectrum

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USSR /Physical Chemistry. Crystals. B-5

Abs Jour : Ref Zhur - Khimiya, No 8, 1957, 25914

Abstract : more rapidly then towards the violet end, and the radiation curve having an opposite course. The bands transform into systems of lines similar to atom spectra at very low temperatures. The mirror symmetry of absorption and luminescence spectra will be achieved the better, the less vibration frequencies of the lattice depend on the electron state of the impurity. The mean radiation life time of impurity centers in the excited state was computed for various temperatures and solvents.

Card : 2/2

Lubchenko, A. F.

Category: USSR / Physical Chemistry - Crystals B-5

Abs Jour: Referat Zhur-Khimiya, No 9, 1957, 29738

Author : Lubchenko A. F.
Inst : Academy of Sciences USSR
Title : Calculation of Mean Radiation Life of Admixture Centers and Localized Excitations of Excitation State

Orig Pub: Izv. AN SSSR, ser. fiz., 1956, 20, No 4, 388-391

Abstract: By generalizing the method of Weisskopf-Wigner (Weisskopf V., Wigner E., Z. Phys., 1930, 63, 54; 65, 18), in the case of atoms and molecules found in solution (solid as well as liquid, with low concentration of admixture), and also in the case of localized excitation at individual molecule of a molecular crystal, the author has calculated their mean radiation life τ in excitation state. Non-radiation transitions are disregarded and therefore the results hold either at low temperatures or in the case of systems in which the energy yield is of the order of unity. Formulas have been derived which give the dependence of τ upon temperature and nature of the solvent, and also the relationship between τ and half-width of luminescence band (if

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Category: USSR / Physical Chemistry - Crystals B-5

Abs Jour: Referat Zhur-Khimiya, No 9, 1957, 29738

the latter is of the form of Gauss curve of errors). Temperature progression of σ (T) is quantitatively in accord with experimental data.

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LUBCHENKO, A.F.

PRIKHOT'KO, A.F.

24(7) p 3 PHASE I BOOK EXPLOITATION SOV/1305

L'vov. Universytet

Materialy X Vsesoyuznogo soveshchaniya po spektroskopii. t. 1: Molekulyarnaya spektroskopiya (Papers of the 10th All-Union Conference on Spectroscopy. Vol. 1: Molecular Spectroscopy) [L'vov] Izd-vo L'vovskogo univ-ta, 1957. 499 p. 4,000 copies printed. (Series: Its: Fizychnyy zbirnyk, vyp. 3/8/)

Additional Sponsoring Agency: Akademiya nauk SSSR. Komissiya po spektroskopii. Ed.: Lazer, S.L.; Tech. Ed.: Saranyuk, T.V.; Editorial Board: Landsberg, G.S., Academician (Resp. Ed., Deceased), Neporent, B.S., Doctor of Physical and Mathematical Sciences, Fabelinskiy, I.L., Doctor of Physical and Mathematical Sciences, Fabrikant, V.A., Doctor of Physical and Mathematical Sciences, Kornitskiy, V.G., Candidate of Technical Sciences, Rayskiy, S.M., Candidate of Physical and Mathematical Sciences, Klimovskiy, L.K., Candidate of Physical and Mathematical Sciences, Miliyanchuk, V.S., Candidate of Physical and Mathematical Sciences, and Glauberman, A. Ye., Candidate of Physical and Mathematical Sciences.

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Card 19/30

LUBCHENKO, A. F.

AUTHOR: Lubchenko, A.F. 21-5-4/26

TITLE: Calculation of Absorption Spectra by Benzyl and Dibenzyl Single Crystals (Raschet spektrov pogloshcheniya sveta monokristallami benzila i dibenzila)

PERIODICAL: Dopovidi Akademii Nauk Ukrains'koi RSR, 1957, Nr 5, pp. 439-443 (USSR)

ABSTRACT: A group-theoretical calculation was carried out by the author in order to determine absorption spectra of benzyl and dibenzyl molecular crystals. The author derives a formula which is more general than Winston's, (R4.3). Applying his own formula (4) to the case of benzyl, the author comes to the following conclusions: That to every excited state of benzyl molecule correspond 3 exciton zones. In the case of a molecular excitation of A-symmetry, the transition into the excited state of A_1-symmetry is forbidden; transition into an excited state of E-symmetry is not forbidden, and its polarization direction is perpendicular to the z-axis. To the molecular excitation of B-symmetry correspond 2 excited states A_2 and E, a transition into the A_2-state being polarized along z and into the E-state perpendicular to z. The results of application of formulae to the case of dibenzyl

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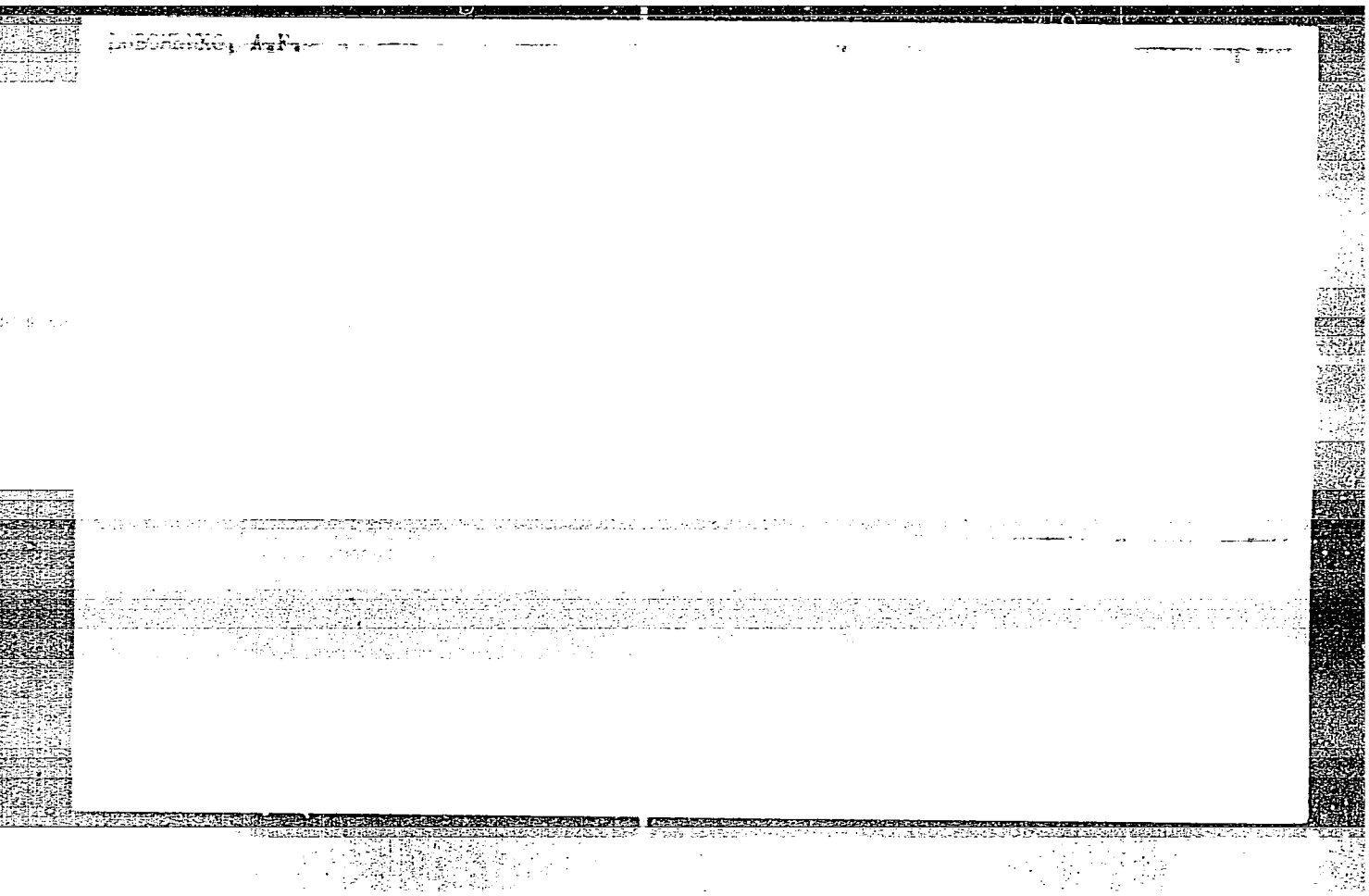

LUBCHENKO, A. F.

Light absorption and dispersion curves in molecular crystals during exciton formation [with summary in English]. Ukr. fiz. zhur. 2 no.4: 310-321 O-D '57. (MIRA 11:3)

1. Institut fiziki AN URSR.
(Light--Scattering) (Absorption of light) (Excitons)

AUTHOR: Lubchenko, A.F. 51-4-6/25

TITLE: Absorption and emission of light by impurity centres. (Pogloshcheniye i izlucheniye sveta primesnymi tsentrami).

PERIODICAL: "Optika i Spektroskopiya" (Optics and Spectroscopy) 1957, Vol.2, No.4, pp.439-447 (U.S.S.R.)

ABSTRACT: Theoretical paper. Phototransitions in impurity centres of an isotropic dielectric are considered. It is assumed that the absorption region of the impurities lies far from the absorption region of the dielectric, i.e. that electrons of the dielectric are more strongly bound and their transition frequencies are much higher than those of impurity electrons. The nuclear vibration frequencies are taken to lie well below the optical transitions of the impurity electrons. These assumptions make it possible to use the adiabatic approximation (W.Pauli, General principles of quantum mechanics, Russian translation, Gostekhizdat, 1947) and to calculate the wave-function of the impurity-dielectric system after emission without taking the interactions of electrons among themselves and with the atomic vibrations to be small. The density of the impurity centres is assumed to be small and their mutual interactions are neglected. The wave-functions of the impurity optical electrons, which depend on the normal coordinates of crystalline and local

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Absorption and emission of light by impurity centres. (Cont.)

vibrations, cannot, in general, be calculated. The matrix element (which involves these wave-functions) of the dipole moment of transitions enters calculations as a parameter. The shapes of the absorption and luminescent bands obtained in this paper are somewhat different from those obtained earlier (A.S.Davydov, Zh.Eksper. Teor. Fiz., Vol.24, 97, 1953; S.I.Pekar, Zh. Eksper. Teor. Fiz., Vol.22, 641, 1952; A.F.Lubchenko, Ukrainskii Fizicheskii Zhurnal, Vol.1, 265, 281, 1956). When the absorption or luminescent band is a sum of separate electron vibration bands then with decrease of temperature a decrease occurs in the intensities of the long-wavelength end of the luminescent band and the short-wavelength end of the absorption band. There are 9 references, 7 of which are Slavic.

ASSOCIATION: Institute of Physics, Academy of Sciences of the Ukrainian S.S.R., Kiev. (Institut Fiziki AN USSR, Kiev)

SUBMITTED: August 10, 1956.
AVAILABLE: Library of Congress

Card 2/2

LUBCHENKO, A.F.

Propagation of electromagnetic waves in molecular crystals with exciton-phonon interactions. Part 1: Absorption and dispersion of electromagnetic waves. Ukr.fiz.zhur. 3 no.5: 575-586 S-O '58. (MIRA 12:2)

1. Institut fiziki AN USSR.
(Crystal lattices) (Electric waves)

LUBCHENKO, A.F.

Propagation of electromagnetic waves in molecular crystals with weak exciton-phonon interactions. Part 2: Natural optical activity [with summary in English]. Ukr. fiz. zhur. 3 no.6:701-711 N-D '58. (MIRA 12:6)

1. Institut fiziki AN USSR.
(Crystals--Optical properties)

AUTHORS: Lubchenko, A.F. and Rashba, E.I. 51-4-5-6/29

TITLE: Exciton States of a Molecular Crystal Containing Different Molecules (Ob eksitonnykh sostoyaniyakh molekulyarnogo kristalla, soderzhashchego razlichnyye molekuly)

PERIODICAL: Optika i Spektroskopiya, 1958, Vol IV, Nr 5, pp 580-585 (USSR)

ABSTRACT: Davydov (Ref 1-3) developed a theory of absorption of light by molecular crystals and proposed a method of calculation of a number of split components and their polarization in absorption of light by crystals containing identical molecules. Another variant of this calculation method, which leads to the same final results, was described in Ref 4. The present authors extend the results of Refs. 1-4 to the case of the crystal whose unit cell contains different molecules and discuss the possible exciton states of such a crystal. The differences between molecules may be due to their chemical structure or due to the fact that they belong to symmetrically independent lattices. The possibility of superposition of molecular excitations with near eigenvalues of energy in states with k = o is investigated. It is shown that such a superposition

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Exciton States of a Molecular Crystal Containing Different Molecules.

occurs only when the representations of local groups, to which the internal molecular wave-functions belong, may be obtained by reduction of one representation of a factor-group. Several special cases are dealt with in detail. They are: (1) crystals with a lattice of the trans-azobenzene ($C_6H_5N{=}NC_6H_5$) type which belongs to the space group C_{2h}^5; (2) crystals with a C_{2h}^4 lattice; (3) crystals of the silver perchlorate with benzene ($C_6H_6{-}AgClO_4$) type which belongs to space group V_h^{17}. The paper is entirely theoretical. The author thanks A.S. Davydov for advice. There are 7 tables and 8 references, 5 of which are Soviet and 3 American.

ASSOCIATION: Institut fiziki AN USSR (Institute of Physics, Academy of Sciences of the Ukrainian SSR.)

SUBMITTED: July 8, 1957

Card 2/2 1. Light - Absorption - Theory 2. Crystals - Molecular excitation

SOV/51-5-4-8/21

AUTHOR: Lubchenko, A.F.

TITLE: On Optical Characteristics of Molecular Crystals in the Exciton Absorption Region (Ob opticheskikh kharakteristikakh molekulyarnykh kristallov v oblasti eksitonnogo pogloshcheniya)

PERIODICAL: Optika i Spektroskopiya, 1958, Vol 5, Nr 4, pp 404-414 (USSR)

TITLE: In the weak-coupling approximation the author obtains general expressions for the extinction coefficient K, the refractive index n and the gyration vector γ of molecular crystals in the exciton absorption region. Calculations of the dependence of n, K and γ on the incident-light frequency were carried out for an isotropic crystal, regarded as a Debye continuum, with the Born condition for definition of ω_{max} at T = 0. Dependence of n, K and γ on the effective exciton mass in an isotropic crystal was also determined. The author thanks A.S. Davydov for valuable discussions.

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Inst. of Physics, AS Ukr SSR

SOV/56-35-6-27/44

24(5)

AUTHORS: Davydov, A. S., Lubchenko. A. F.

TITLE: Electromagnetic Waves in Crystals in the Region of Exciton Absorption (Elektromagnitnyye volny v kristalle v oblasti eksitonnogo pogloshcheniya)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1958, Vol 35, Nr 6, pp 1499-1507 (USSR)

ABSTRACT: Pekar (Ref 1), Ginzburg (Ref 2) and Agranovich and Rukhadze (Ref 3) investigated the propagation of light waves in the case of spatial dispersion. They showed that in frequency ranges near the exciton absorption band, waves with the same frequency, propagation direction, and polarization may have different refraction indices. Only the transparency domain was investigated in this connection. A reduction of the amplitudes of electromagnetic oscillations during their passage through matter is a consequence of 1) scattering of the wave and b) of energy transfer from the wave to particle motion (genuine absorption). In the present paper only genuine absorption at crystal temperatures near absolute zero is investigated, namely for a frequency range that coincides with the exciton absorption band. Because of the connection between genuine ab-

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Electromagnetic Waves in Crystals in the Region of Exciton Absorption

sorption and the innermolecular excitations and oscillations of the molecule, the absorption band broadens also at temperatures near 0°K. Davydov (Ref 4) showed that an excitation in molecule crystals by light waves occurs in two different ways: a) as a localized excitation and b) as an exciton excitation. The absorption bands according to a) have nearly a Gaussian distribution and are independent of crystal structure, those according to b) depend essentially on crystal structure. Thus, investigation of the band structure of exciton absorption offers a possibility of investigating crystal structure, of the dependence of the energy of the exciton state on the wave vector of the exciton, and of exciton interaction with lattice oscillations. Davydov (Ref 5) as well as Davydov and Rashba (Ref 6) developed a theory of the structure of light absorption bands by basing on the example of a onedimensional crystal and on a more general case, without, however, considering the dependence on refraction- and absorption coefficients. In the present paper the authors develop a theory that furnishes refraction index and absorption coefficient in absorption bands corresponding to exciton excitations. They operate with the model of the pure molecule crystal, in which molecules are able

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to perform only translation- and rotation oscillations of a certain (average) value. It is shown that knowledge of the structure of the absorption band may be instrumental in determining the sign of the effective exciton mass. Furthermore, the conditions are given which lead to a zero refraction index at the short wave side of the excitation band. Electromagnetic waves of these frequencies are totally reflected, they penetrate only very little into the crystal surface. This total reflection is found to vanish with rising temperature. There are 3 figures and 8 Soviet references.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet (Moscow State University)

SUBMITTED: June 26, 1958

RASHBA, E.I.; SNITKO, O.V.; TOLPYGO, K.B.; LUBCHENKO, A.F.; SHEYNKMAN, M.K.; LASHKAREV, V.Ye., akademik, otv.red.; KISINA, I.V., red. izd-va; MATVEYCHUK, A.A., tekhn.red.

[Photoelectrical and optical phenomena in semiconductors. Works of the First All-Union Conference on Photoelectrical and Optical Phenomena in Semiconductors held at Kiev, November 20-26, 1957] Fotoelektricheskie i opticheskie iavleniia v poluprovodnikakh. Trudy Pervogo Vsesoiuznogo soveshchaniia po fotoelektricheskim i opticheskim iavleniiam v poluprovodnikakh, Kiev, 20-26 noiabria 1957 g. Kiev, Izd-vo Akad.nauk USSR, 1959. 403 p. (MIRA 12:11)

1. Akademiya nauk SSSR. Komissiya po poluprovodnikam. 2. AN USSR (for Lashkarev).

(Semiconductors)

PASECHNIK, M.V. [Pasichnyk, M.V.]; LUBCHENKO, A.F.; MENTKOVSKIY, Yu.L. [Mentkovs'kyi, IU.L.]

Ninth International Conference on High energy Physics. Ukr. fiz.zhur. 4 no.6:816-830 N-D '59. (MIRA 14:10)
(Nuclear physics--Congresses)

LUBCHENKO, A.F.

Relationship between polarization and electromagnetic field intensity in the region of exciton absorption. Fiz.tver.tela 1 no.5:709-717 My '59. (MIRA 12:4)

1. Institut fiziki AN USSR, Kiyev.
(Excitons) (Crystal lattices)

LUBCHENKO, A.F.

Propagation of electromagnetic waves in molecular crystals in weak exciton - photon interactions. Part 3: Magneto-optical effects. Ukr. fiz. zhur. 4 no.2:183-200 Mr-Ap '59. (MIRA 13:1)

1. Institut fiziki AN USSR.
(Excitons) (Photons) (Crystals)

SOV/51-7-1-12/27

24(3), 24(4), 24(2)

AUTHORS: Brodin, M.S. and Lubchenko, A.F.

TITLE: The Effect of Temperature on Propagation of Electromagnetic Waves in Crystals in which Excitons are Formed (Vliyaniye temperatury na rasprostraneniye elektromagnitnykh voln v kristallakh, v kotorykh voznikayut eksitony)

PERIODICAL: Optika i spektroskopiya, 1959, Vol 7, Nr 1, pp 83-88 (USSR)

ABSTRACT: The authors discuss equations which give the refractive (n) and absorption (χ) indices for crystals in which excitons may be formed. These equations are given for weak coupling of excitons with the lattice vibrations. It is shown that with increase of temperature these equations tend to assume the form of the usual equations for n and χ in classical crystal optics. This tendency increases with the increase of the effective exciton mass and with the increase of the strength of the exciton-phonon interaction. Using Kramers--Kronig formulae the authors calculated the dispersion curves for anthracene and stilbene and compared the calculated curves with experimental ones (Figs 1, 2). It was found, in agreement with the above conclusions, that the differences between the calculated and experimental curves become

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The Effect of Temperature on Propagation of Electromagnetic Waves in Crystals in which Excitons are Formed

smaller as temperature increases. At a given temperature the agreement between experimental and theoretical curves improves on transition from the electronic absorption bands to near electron-vibrational bands. Acknowledgments are made to A.F. Prikhot'ko and A.S. Davydov for their advice. There are 2 figures, 1 table and 13 references, 11 of which are Soviet, 1 translation from German into Russian and 1 English.

SUBMITTED: July 23, 1958.

SOV/51-7-3-8/21

AUTHOR: Lubchenko, A.F.

TITLE: Theory of the Faraday Effect in the Region of Exciton Absorption of Light by Molecular Crystals

PERIODICAL: Optika i spektroskopiya, 1959, Vol 7, Nr 3, pp 332-340 (USSR)

ABSTRACT: The author presents a theory of the Faraday effect in molecular crystals, in which excitons interact weakly with the lattice vibrations and which can have any value of the absorption factor. The gyration vector which determines rotation of the plane of polarization in an external magnetic field, is calculated. Formulae are obtained which give the dispersion of the Verdet coefficient for crystals of higher and medium syngonies and the values of the refractive index near the exciton absorption bands. The paper is entirely theoretical. Acknowledgment is made to A.S. Davydov for his advice. There are 8 Soviet references.

SUBMITTED: December 15, 1958

Card 1/1

SOV/51-7-3-9/21

AUTHOR: Lubchenko, A.F.

TITLE: Theory of the Linear Kerr Effect in the Region of Exciton Absorption of Light by Molecular Crystals

PERIODICAL: Optika i spektroskopiya, 1959, Vol 7, Nr 3, pp 341-348 (USSR)

ABSTRACT: The author develops a theory of the linear Kerr effect for molecular crystals in which excitons interact weakly with the lattice vibrations and which can have any value of the absorption factor. Equations are obtained which give the propagation of light, in the exciton absorption region, in the presence of a constant uniform external electric field. The author calculates a third-rank tensor which determines the optical anisotropy and finds the magnitude of birefringence in crystals of cubic and medium syngonies on propagation of light along the direction of the external applied electric field, which is parallel to the axis of the highest order. The paper is entirely theoretical. Acknowledgment is made to A.S. Davydov for his advice. There are 7 references, 4 of which are Soviet, 1 translation from German into Russian and 2 English.

SUBMITTED: December 15, 1958

Card 1/1

S/185/60/005/002/017/022
D274/D304

AUTHOR: Lubchenko, A.F.

TITLE: On the correlation between collective- and extra-nucleon motion

PERIODICAL: Ukrayins'kyy fizychnyy zhurnal, v. 5, no. 2, 1960, 274-276

TEXT: Recently, attempts were made to consider the case of intermediate coupling by the Tamm-Dankov method. In the present article, an attempt is made to calculate the correlation between the motion of extranucleons and the collective motion for the case of non-fulfilment of the criterion of the adiabatic approximation; the method followed has proved successful in the theory of the solid state: V.M. Buymistrov (Ref. 6: UFZh, 2, 12, 1957). For simplicity, a spheric-symmetrical nucleus with one extra-nucleon is considered; its Hamiltonian is

$$H = H_0 - R_0 k(r) \sum_{\mu=-2}^{2} \alpha_\mu Y_2 + \frac{1}{2} \sum_{\mu=-2}^{2} \{B|\alpha_\mu|^2 + C|\alpha_\mu|^2\} \qquad (1)$$

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On the correlation...

H_o is the operator of the extra-nucleon; all the other notations are analogous to those of A. Bohr (Ref. 1: Dansk. Mat. Fys. Medd., 26, 14, 1952), for $\lambda = 2$. In solving the equation $H\psi = E\psi$, the variational method is used. The extremum of the functional

$$I[\psi] = \int \psi^*_{m\mu} H \psi_{m\mu} \, d\tau \qquad (3)$$

is sought, with the condition

$$\int \psi^*_{m\mu} \psi_{m'\mu} \, d\tau = \delta_{mm'} \delta_{\mu\mu'}.$$

$m\mu$ is the totality of quantum numbers which characterize the state of the nucleus. After some computations, an expression is obtained which leads to complicated integro-differential equations of the Euler-type; such equations cannot, practically, be solved; therefore a direct variational method is used which leads to the expression

$$I[\psi] = \int \psi_m H_o \psi_m dr + \frac{5}{2}\hbar\omega - \frac{1}{2} \sum_{i=0}^{2} \sum_{\mu=0}^{2} \frac{1}{\hbar\omega} \left(\int |\psi_m|^2 V_i dr \right)^2 -$$

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S/185/60/005/002/017/022
D274/D304

On the correlation...

$$-\frac{1}{2}\sum_{i=1}^{2}\sum_{\mu=0}^{2}\left[\int|\psi_m|^2\varphi^{\mu}_i dr\int|\psi_m|^2 V_i dr \pm \int|\psi_m|^2 \varphi^{\mu}_i dr\right]^2 \Big| K_i, \quad (7)$$

where

$$K_i = \frac{\hbar^2}{2M}\int|\psi_m|^2(\nabla\varphi^{\mu}_i)^2 dr + \hbar\omega\left[\int|\psi_m|^2(\varphi^{\mu}_i)^2 dr - \left(\int|\psi_m|^2\varphi^{\mu}_i dr\right)^2\right]$$

where ψ_m is the wave function of the extra-nucleon; the plus-sign corresponds to V_1, and the minus-sign to V_2. In the limiting case of strong coupling, when the last term of Eq. (7) can be ignored, the functional obtained is similar to that for the adiabatic approximation. If (for weaker coupling) the last term is taken into account, this leads to a reduction in the energy of single-particle levels as compared to the energy obtained in the adiabatic approximation; for different single-particle levels these reductions in energy will be different; this cannot be obtained by changing the value of V_0 only. There are 7 references: 4 Soviet-bloc and 3 non-Soviet-bloc. The reference to the English-language publication reads as follows: A Kerman, Phys. Rev., 92, 1176, 1953.

Card 3/3

Inst. Physics AS UkR SSR

DZYUB, I.P.; LUBCHENKO, A.F.

Scattering of γ-quanta by the nuclei of a solid. Fiz. tver. tela 3 no.8:2275-2284 Ag '61. (MIRA 14:8)

1. Institut fiziki AN USSR, Kiyev.
(Gamma rays--Scattering)
(Quantum electrodynamics)

32073
S/181/61/003/012/007/028
B102/B108

24,3500 (1137, 1138)

AUTHORS: Dzyub, I. P., and Lubchenko, A. F.

TITLE: Resonance scattering of light from impurity centers in a solid

PERIODICAL: Fizika tverdogo tela, v. 3, no. 12, 1961, 3602 - 3613

4

TEXT: A theory of resonance scattering by impurities is developed. The shapes of the excitation and resonance luminescence spectra, their temperature dependence and other solid-state characteristics are studied. The theory is based on the following assumptions: The solid is considered a dielectric solvent containing impurities in such a low concentration that interaction between impurity centers may be neglected. An arbitrary dispersion law is valid. The system consists of the "solid solution" and the radiation field, the absorption range of the solid being far from the impurity absorption range. The excited impurity level l_1 be not degenerate, and far from the other electron levels, which are neglected. Resonance scattering of light, owing to the perturbation H' is described by

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Resonance scattering of...

$l_0(n_s^0)(N_\sigma) \to l_1(n_s)(N_{\sigma'}-1) \to l_0(n_s')(N_{\sigma'}-1, N_{\sigma''}+1)$, where l_0 denotes all the quantum numbers of the ground states of optical impurity electrons. If this sequence of transitions is characterized by 0, 1, 0', the transition probability amplitudes b_0, b_1, and $b_{0'}$ are given by

$$\left.\begin{aligned} b_0 &= \exp\left\{-\frac{\Gamma t}{2}\right\}, \\ b_1 &= c_{n_s}\left[\exp\left\{-\frac{\Gamma t}{2}+\frac{it}{\hbar}(E_1-E_0)\right\}-\exp\left\{-\frac{\gamma_1 t}{2}\right\}\right] \end{aligned}\right\} \quad (4)$$

with

$$\gamma_1 = \frac{2\pi}{\hbar^2}\overline{|\langle l_1|H'_{\sigma''}|l_0\rangle|^2}\,\rho(\Omega_{l_1 l_0}), \quad (5)$$

$$c_{n_s} = \frac{\langle 1|H'_{\sigma'}|0\rangle}{E_0 - E_1 + i\hbar\frac{\gamma_1-\Gamma}{2}}. \quad (6)$$

The initial conditions are $b_i(0) = \delta_{i0}$, i = 0, 1, 0'. $\hbar\Omega_{l_1 l_0} = E_{l_1}(0)(0) - E_{l_0}(0)(0)$, $\rho(\Omega_{l_1 l_0})$ is the density of the radiation oscillators of the

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Resonance scattering of...

frequency $\Omega_{l_1 l_0}$. $\overline{|\langle l_1|H'_{\sigma''}|l_0\rangle|^2}$ is the result of an integration of the square matrix element of H' with respect to ψ_{l_1} over the solid angle and summation over the polarizations of the scattered quanta. The expression

$$W(\omega_{\sigma'}, \omega_{\sigma''}) = \frac{2M}{\Gamma\hbar^4}\int_0^\infty\int dt dt' e^{i(t'-t)\beta - \frac{\Gamma}{2}(t+t')+g(t')+g^*(t)} \operatorname{Re}_p \int_0^\infty d\mu e^{-i\mu\omega_0 + K(tt'\mu)}. \quad (10)$$

with

$$e_0 = \omega_{\sigma''} - \omega_{\sigma'},\ \beta = -\Omega_{l_1 l_0} + \omega_{\sigma''},\ M = |\langle l_0|H'_{\sigma'}|l_1\rangle|^2 |\langle l_0|H'_{\sigma''}|l_1\rangle|^2,$$

$$K(tt'\mu) = \sum_s \xi^2_{sl_1}[(\bar{n}_s+1)P_s(tt')e^{-i\mu\omega_s} + \bar{n}_s P_s^*(tt')e^{i\mu\omega_s}], \quad (11)$$

$$g(t') = \sum_s \xi^2_{sl_1}[(\bar{n}_s+1)\exp(-it'\omega_s) + \bar{n}_s\exp(it'\omega_s) - (2\bar{n}_s+1)], \quad (12)$$

$$P_s(tt') = (1-e^{it'\omega_s})(1-e^{-it\omega_s}),$$

is derived for the scattering probability. $g^*(t)$ and $P_s^*(tt')$ are obtained

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Resonance scattering of...

from $g(t')$ and $P_s(tt')$ by substituting -t for t' and t' for -t, respectively. The width Γ of the ground level, defined by

$$\Gamma=\frac{2\pi}{\hbar^2}\overline{|\langle l_0|H'_{\sigma'}|l_1\rangle|^2}\rho(\Omega_{l_1l_0}). \qquad (7),$$

is proportional to the intensity of the incident quantum flux. φ_1 and ψ are the wave functions of the optical impurity electrons and of the other electrons, respectively; ξ_{sl} denotes the displacement of the solvent nuclei from their equilibrium position, ω_s is the frequency of the normal oscillations of the solvent, n_s the population of the phonon field. Eq. (10) determines the resonance scattering probability for arbitrary frequency dispersion of the normal oscillations of the solution, arbitrary ξ_{sl_1} and arbitrary temperature. For the excitation spectrum,

$$W(\omega_{\sigma'})=\frac{8\pi\gamma_1}{\hbar\Gamma\gamma}\omega_{\sigma'}\overline{|\langle l_0|H_{\sigma'}|l_1\rangle|^2}\left[NI_1(\omega_{\sigma'})+\sum_{j=1}^{N}I_2^j(\omega_{\sigma'})\right]. \qquad (16)$$

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Resonance scattering of...

results, if

$$\frac{1}{2}\sum_{i}\xi^{2}_{il_1}(2n_i+1)\left(\frac{\omega_i}{\omega_0}\right)^2>1 \qquad (15)$$

is fulfilled. The phonon part of the excitation spectrum, defined by

$$I_1(\omega_{el'})=\mathrm{Re}\int_0^{\infty} e^{i\alpha_0\beta'_j-\frac{1\alpha}{2}+g(\alpha)}\,dx=$$

$$=\frac{\sqrt{\pi}}{2B}e^{-\frac{\alpha^2}{4B^2}}\left[1+\frac{3D+3C\alpha}{4B^4}-\frac{6D\alpha^2+C\alpha^3}{(2B^2)^3}+\frac{D\alpha^4}{(2B^2)^4}+\ldots\right]$$

$$\alpha=\Omega_{l_1l_0}+A-\omega_{el'}.$$

is thus Gaussian. If (15) is not fulfilled (low heat release), the excitation spectrum is a sum of Lorentz curves. The resonance luminescence spectrum is given by

$$S^{j}(\omega_{el'})=\int_0^{\infty}dy\,\mathrm{Re}_y\int_0^{y}dxF(x,\,y), \qquad (21)$$

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Resonance scattering of...

$$F(x, y)=\exp\left\{i\beta_f x-\frac{\gamma y}{2}+g(x)-4i\sum_s \xi^2_{sl_1}\sin\frac{x\omega_s}{2}\cos\frac{\omega_s y}{2}\right\}.$$

or, if no frequency dispersion is present, by

$$S^f(\omega_{\sigma''})=e^{-a}\sum_{l,\,m=-\infty}^{\infty} J^2_m(2a)\left(\frac{b}{c}\right)^{\frac{l}{2}}\frac{I_{|l|}(2\sqrt{bc})}{\left(\omega_{\sigma''}-\Omega^f_{l_1l_0}+\omega l-m\omega\right)^2+\frac{\gamma^2}{4}},$$

$$b=\sum_s \xi^2_{sl_1}(\bar{n}_s+1),\quad c=\sum_s \xi^2_{sl_1}\bar{n}_s,$$

with $\sum_s \xi^2_{sl_1}=a$, $I_{|l|}$ is a Bessel function of $|l|$-th order of an imaginary argument. If (15) is not fulfilled and $\sum_s \xi^2_{sl_1}(n_s+1)<1$,

$$S^f(\omega_{\sigma''})=e^{-a}\sum_{\substack{\ldots\tau_s\ldots\\ \ldots\tau'_s\ldots}}\prod_s\frac{b_s^{\tau_s}a_s^{\tau'_s}}{\tau_s!\,\tau'_s!}\frac{1}{\left[\omega_{\sigma''}-\Omega^f_{l_1l_0}+\sum_s\omega_s(\tau_s-\tau'_s)\right]^2+\frac{\gamma^2}{4}}.$$

Card 6/7

Resonance scattering of...

It is then shown that the shape of the resonance luminescence spectrum depends to a considerable extent on the shape of the irradiation spectrum. A. S. Davydov is thanked for discussions. There are 15 references: 7 Soviet and 8 non-Soviet. The four most recent references to English-language publications read as follows: Huang Kun, A. Phys. Proc. Roy. Soc. 204, 406, 1950; M. Lax. J. Chem. Phys. 20, 1752, 1952; R. Kubo, Y. Toyozawa. Progr. Theor. Phys. 13, 160, 1955; G. N. Watson. Theory of Bessel Functions, New York, 1945.

ASSOCIATION: Institut fiziki AN USSR Kiyev (Institute of Physics AS UkrSSR, Kiyev)

SUBMITTED: June 29, 1961

Card 7/7

S/051/61/010/003/003/010
E032/E514

AUTHOR: Lubchenko, A.F.

TITLE: The Cotton-Mouton Effect in the Region of Impurity Absorption of Light

PERIODICAL: Optika i spektroskopiya, 1961, Vol.10, No.3, pp.379-383

TEXT: It was shown in a previous paper (Ref.1) that in the presence of a constant external magnetic field directed along the OZ axis, the polarization of a solution due to a light-wave can be written down in the form

$$\mathbf{p}_1 = \frac{\varepsilon - 1}{4\pi}\mathbf{E}_1 + \frac{1}{Zh}\sum_{jmm_0} e^{-H\zeta_{m_0}/kT}\langle l_1 m|\mathbf{p}^j|l_0 m_0\rangle\langle\langle l_0 m_0|\mathbf{p}^j|l_1 m\rangle\times \quad (1)$$
$$\times\chi^j\mathbf{E}_1)(F^j_m - iS^j_m).$$

In this expression ε is the dielectric constant of the solution due to all virtual transitions other than that under consideration (it is assumed that ε is a slow function of frequency), $\underline{E}_1$ is the electric vector of the light-wave, H is the z-component of the external magnetic field, $Z = \sum_{m_0} \exp\left(\frac{-H\zeta_{m_0}}{kT}\right)$, $H\zeta_{m_0}$ is the addition to the

energy of the ground state of the solution due to the external magnetic field, m, m_o are the magnetic quantum numbers (the field in which the impurity centre is located is looked upon as a perturbation), $\langle l_1 m | p^j | l_o m_o \rangle$ are the matrix elements of dipole moments of the j-th impurity centre and F_m^j and S_m^j are functions which represent the refractive index and absorption coefficient of the impurity centres, respectively. The remaining symbols are said to be defined in Ref.1. In the present paper the analysis is confined to isotropic solvents and it is assumed that the light is propagated along the OX axis in the solution, which is perpendicular to the magnetic field. Bearing in mind that the matrix elements $\langle l_1 m | p | l_o m_o \rangle$ have non-zero values only when $m = m_o \pm 1$ and $m = m_o$ and neglecting the dependence of χ on H, Eq.(1) can be rewritten in the form

$$p_1 = \frac{\varepsilon - 1}{4\pi} E_1 + \frac{N\chi}{2h} \sum_{m_o}^{V} e^{-\pi\varepsilon_{m_o}/kT} \left((l_1 m_0 + 1 | p | l_0 m_0)(l_0 m_0 | pE_1 | l_1 m_0 + 1) \times \right.$$
$$\times (F_{m_o+1} - iS_{m_o+1}) + (l_1 m_0 - 1 | p | l_0 m_0)(l_0 m_0 | pE_1 | l_1 m_0 - 1)(F_{m_o-1} - iS_{m_o-1}) +$$
$$\left. + (l_1 m_0 | p | l_0 m_0)(l_0 m_0 | pE_1 | l_1 m_0)(F_{m_o} - iS_{m_o}) \right).$$

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Here, N is the number of impurity centres per unit volume of the solution and the accented summation sign indicates summation over those values of m_0 for which in the excited state $m = m_0 \pm 1$. Next, using the general properties of matrix elements (YE. Condon, G. Shortley, Ref.2) and the notation

$$R = \frac{1}{Z}\sum_{m_0}{}' e^{-H\varepsilon_{m_0}/kT}\left[|A_{m_0}|^2(F_{m_0+1} - iS_{m_0+1}) + |B_{m_0}|^2(F_{m_0-1} - iS_{m_0-1})\right],$$

$$Q = \frac{1}{Z}\sum_{m_0}{}' e^{-H\varepsilon_{m_0}/kT}\left[|A_{m_0}|^2(F_{m_0+1} - iS_{m_0+1}) - |B_{m_0}|^2(F_{m_0-1} - iS_{m_0-1})\right],$$

$$P = \frac{1}{Z}\sum_{m_0}{}' e^{-H\varepsilon_{m_0}/kT}|D_{m_0}|^2(F_{m_0} - iS_{m_0}),$$

where

$$\alpha(l_1 m_0 + 1 | P_x | l_0 m_0) = \mp A^*_{m_0}, \qquad \alpha(l_0 m_0 | P_x | l_1 m_0) = 0,$$
$$\alpha(l_1 m_0 + 1 | P_y | l_0 m_0) = \mp (iA_{m_0})^*, \qquad \alpha(l_0 m_0 | P_y | l_1 m_0) = 0,$$
$$\alpha(l_1 m_0 \pm 1 | P_z | l_0 m_0) = 0, \qquad \alpha(l_0 m_0 | P_z | l_1 m_0) = D_{m_0},$$
$$\alpha(l_1 m_0 - 1 | P_x | l_0 m_0) = \pm B^*_{m_0}, \qquad \alpha = \sqrt{4\pi h^{-1} N \gamma_1},$$
$$\alpha(l_1 m_0 + 1 | P_y | l_0 m_0) = \pm(-iB_{m_0})^*,$$

the expressions for the components of the induction vector can be written down in the form

$$\left.\begin{aligned} D_x &= (\varepsilon E)_x + RE_y + iQE_y, \\ D_y &= (\varepsilon E)_y - iQE_x + RE_y, \\ D_z &= (\varepsilon E)_z + Q'E_z. \end{aligned}\right\} \quad (2)$$

Using the expression for the dielectric-constant tensor given in Ref.1, Eq. (2) can be rewritten in the form:

$$\left.\begin{aligned} D_x &= (\varepsilon' + R)E_x + i(Q + \varepsilon''_{12})E_y, \\ D_y &= (\varepsilon' + R)E_y - i(Q + \varepsilon''_{12})E_x, \\ D_z &= (\varepsilon_{33} + Q')E_z. \end{aligned}\right\} \quad (3)$$

Eq.(3), together with the equation for plane waves in the medium

$$\underline{D} = N^2 \left[\underline{E} - s(s\underline{E})\right] \quad (4)$$

Card 4/6

where $N = n - i\varkappa$ is the complex refractive index and s is the unit vector along the wave normal, determine the propagation of light in the solution in the presence of a constant external magnetic field. It is shown from these equations that

$$n_1 = \sqrt{\varepsilon'} + \frac{1}{2Z\sqrt{\varepsilon'}} \sum{}' e^{-H\zeta_{m_0}/kT} \left\{ |A_{m_0}|^2 F_{m_0+1} + |B_{m_0}|^2 F_{m_0-1} \right\}.$$

$$n_2 = \sqrt{\varepsilon_{33}} + \frac{1}{2Z\sqrt{\varepsilon_{33}}} \sum_{m_0}{}' e^{-H\zeta_{m_0}/kT} |D_{m_0}|^2 F_{m_0}.$$

The final part of the paper is concerned with double refraction in the region of impurity absorption. Using the above expressions for n_1 and n_2, the birefringence can be written down in the form

$$\Delta = n_1 - n_2 = \sqrt{\varepsilon'} - \sqrt{\varepsilon_{33}} + \\ + \frac{1}{2Z} \sum_{m_0}{}' e^{-H\zeta_{m_0}/kT} \left\{ \frac{|A_{m_0}|^2}{\sqrt{\varepsilon'}} F_{m_0+1} + \frac{|B_{m_0}|^2}{\sqrt{\varepsilon'}} F_{m_0-1} - \frac{|D_{m_0}|^2}{\sqrt{\varepsilon_{33}}} F_{m_0} \right\}. \quad (15)$$

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It follows from this expression that in the region of impurity absorption the birefringence is not, in general, proportional to H^2 but depends on the magnetic field in a more complicated fashion. Moreover, the birefringence is a function of temperature. In order to investigate Eq.(15) in greater detail, a specific case of a solvent and impurity centre must be considered. The present author takes the case of an isotropic solvent and an impurity centre having a central symmetry. It is shown that under certain further simplifying assumptions birefringence at low temperatures is the sum of two terms, one of which is linear and the other quadratic in H. Acknowledgments are expressed to A. S. Davydov for valuable discussions and interest. There are two Soviet references, one a translation from German.

SUBMITTED: May 21, 1960

LUBCHENKO, A.F.

Magnetic rotation of the plane of polarization in the region of the impurity absorption of light. Opt. i spektr. 10 no.4:477-486 Ap '61. (MIRA 14:3)

(Polarization (Light))
(Absorption spectra)

26442
S/048/61/025/007/004/005
B108/B209

24,6410

AUTHORS: Dzyub, I. P., and Lubchenko, A. F.

TITLE: Emission, absorption, and reabsorption of gamma quanta by impurity nuclei in solid solutions

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Seriya fizicheskaya, v. 25, no. 7, 1961, 893 - 900

TEXT: This paper was read at the XI Annual Conference on Nuclear Spectroscopy in Riga, January 25 - February 2, 1961. Emission and absorption probability of gamma-radioactive impurities are calculated in adiabatic approximation. It is assumed that the theory of the Mössbauer effect refers to translatory symmetry in the solid solution and that impurity concentration is low so that interaction between the impurity atoms is negligible. The steady state equation for the solid solution has the form $H_0\psi(\varrho,r,R) = (E - E_f)\psi(\varrho,r,R)$ (1), where E_f denotes the energy of the radiation field. The solution to this equation may be set up as $\psi(\varrho,r,R) = \Phi_m^i(\varrho)\cdot\chi(r,R)$, $\Phi_m^i(\varrho)$ being the wave function of all

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Emission, absorption, and...

impurity nuclei for the case where the excitation is characterized by the quantum number m and is localized to the i-th nucleus. The wave function of the system solid solution plus radiation field and the corresponding eigenvalues of energy are obtained in the form

$$\Phi_{l\{n_s\}\{N_\sigma\}} = C(\ldots N_\sigma \ldots)\,\Phi_m^l(\rho)\,\psi_l(r, R)|n_s\rangle, \qquad (7).$$

$$E_{l\{n_s\}\{N_\sigma\}} = E_m + E_l + U_l^l(R_0) + \sum_s \hbar\omega_s^l (n_s + {}^1/_2),$$

C is the wave function of the radiation field, $|n_s\rangle$ a wave function determined by the occupation number n_s; ρ, r, and R refer to the nuclei and electrons of the impurities and to the "solvent", respectively. Assuming the matrix elements of $1_1 \rightarrow 1_i$ transitions ($i \neq 0$) to be smaller than the matrix element of the $1_1 \rightarrow 1_0$ transition (which is considered here) the authors obtain the following formula for the emission probability:

$$w_l^l = |L|^2 W_l^l = |L|^2 \frac{2}{\Gamma} R_e \int_0^\infty d\mu e^{-i\mu(E - E_0^l) - \mu\Gamma/2} F(\mu), \qquad (10);$$

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Emission, absorption, and...

$$F(\mu)=\prod_{s}\frac{1-e^{-\hbar\omega_s^{l_1}/\theta}}{1-e^{-\hbar\omega_s^{l_1}/\theta+i\mu\hbar\left(\omega_s^{l_1}-\omega_s^{l_0}\right)}}\exp\left\{|\varkappa_{sl_1}^{j}|^2\left(1-e^{i\mu\hbar\omega_s^{l_1}}\right)-\right.$$

$$\left.-|\varkappa_{sl_1}^{j}|^2\,|\,e^{i\mu\hbar\omega_s^{l_1}}-1\,|^2\frac{1}{1-e^{-\hbar\omega_s^{l_1}/\theta+i\mu\hbar\left(\omega_s^{l_1}-\omega_s^{l_0}\right)}}\right\}, \qquad (10);$$

$$\varkappa_{sl_1}^{j}=i\left(\frac{1}{2M_j\hbar\omega_s^{l_1}}\right)^{1/2}\sum_{\alpha=1}^{3}p_\alpha q_{\alpha s}^{j},$$

$$R_e=\sum_s|\varkappa_{sl_1}^{j}|^2\hbar\omega_s^{l_1}.$$

$E_o^j = E_{m1} - E_{mo} + U_{11}^j - U_{1o}^j$; L denotes the nuclear matrix element, $\vec{p}$ the momentum of the gamma quanta. By splitting the integral in Eq. (10) into two portions with limits $[0, \mu_0]$ and $[\mu_0, \infty]$ one can find Eq. (12) on condition (11):

$$\sum_s|\varkappa_{sl_1}^{j}|^2\,\mathrm{cth}\frac{\hbar\omega_s^{l_1}}{2\theta}\left(\frac{\omega_s^{l_1}}{\omega_{s\,\text{макс}}}\right)^2>1, \qquad (11),$$

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$$\frac{2}{\Gamma} R_e \int_0^{\mu_0} d\mu e^{-\frac{1}{2}\mu(E-E_0^j)-\mu\Gamma/2} F(\mu) = \frac{4}{\Gamma^2}\left[1 + \frac{C_e a_e^3}{8B_e^6} + \frac{D_e a_e^4}{16B_e^8} + \cdots\right]\psi(x, \eta). \quad (12)$$

Здесь

$$B_e^2 = \frac{1}{2!}\sum_s |\varkappa_{sl_1}^j|^2 \operatorname{cth}\frac{\hbar\omega_s^{l_1}}{2\theta}\cdot(\hbar\omega_s^{l_1})^3, \qquad (12).$$

$$C_e = \frac{1}{3!}\sum_s |\varkappa_{sl_1}^j|^2 (\hbar\omega_s^{l_1})^3,$$

$$D_e = \frac{1}{4!}\sum_s |\varkappa_{sl_1}^j|^2 \operatorname{cth}\frac{\hbar\omega_s^{l_1}}{2\theta}\cdot(\hbar\omega_s^{l_1})^4,$$

$$a_e = E_0^j + \sum_s \hbar(\omega_s^{l_1} - \omega_s^{l_1})\,\bar{n}_s - E - R_e;$$

$$\bar{n}_s = \left[\exp\left\{\frac{\hbar\omega_s^{l_1}}{\theta}\right\} - 1\right]^{-1},$$

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$x = \frac{2\alpha_e}{\Gamma}$; $\eta = \frac{4B_e}{\Gamma}$; $\psi(x,\eta) = \int_0^\infty dy \cos xy e^{-y-y^2\eta^2/4}$ is the function determining the shape of the emission curve of a free nucleus in consideration of the Doppler effect. Condition (11) holds in the case of great heat liberation. Similar deliberations are made for small heat liberation. Conclusions: (1) The absorption and emission curves are Gaussian at high temperatures, with a Mössbauer line superimposed. In the energy spectrum, the Mössbauer line is right of the maximum of the phonon part in the emission spectrum, and left of it in the absorption spectrum. (2) The intensity of the Mössbauer line rises sharply with decreasing temperature. (3) High-frequency vibrations play a leading part in the interaction between nuclear transition and normal vibrations. (4) In the case of small heat liberation, the absorption and emission curves are a superposition of Lorentz curves of half-width $\Gamma/2$. (5) When the impurity atoms occupy different sites in the solution and, accordingly, U_1^j depends on the position of the atoms, the shape of the Mössbauer line will be determined by the expression $\sum_j \frac{1}{(E - E_1^j)^2 + \Gamma^2/4}$. A short section of the paper is devoted to the

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dependence of reabsorption on the thickness of the absorber and on the velocity at which absorber and emitter are relatively moving. There are 14 references: 6 Soviet-bloc and 8 non-Soviet-bloc.

ASSOCIATION: Institut fiziki Akademii nauk USSR (Physics Institute of the Academy of Sciences UkrSSR)

26443
S/048/61/025/007/005/005
B108/B209

24.6400

AUTHORS: Dzyub, I. P., and Lubchenko, A. F.

TITLE: Resonance scattering of gamma quanta from nuclei in a solid

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Seriya fizicheskaya, v. 25, no. 7, 1961, 901 - 908

TEXT: This paper was read at the XI Annual Conference on Nuclear Spectroscopy in Riga, January 25 - February 2, 1961. The authors determined the angular distribution and the spectrum of scattered gamma quanta, as well as the excitation spectrum. It is possible to determine the frequencies of normal vibrations of the scatterer either from the spectrum of gamma scattering or from the intensity of the Mössbauer line, which appears also for other than Bragg angles. In calculating the probability of resonance scattering several resonance-scattering nuclei are assumed to be among the m atoms in an elementary cell. The states of the scatterer and of the radiation field are characterized by a set of quantum numbers $1\{n_s\}\{N_\sigma\}$, where n_s and N_σ are the occupation numbers of the phonon and photon fields, respectively. On the assumption that the virtual transitions

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Resonance scattering of...

are negligible, the process of resonance scattering may be considered as a sequence of transitions: $1_0\{n_s^0, N_{\sigma'}\} \longrightarrow 1_1\{n_s\}\{N_{\sigma'}-1\} \longrightarrow 1_0\{n_s'\}\{N_{\sigma'}-1, N_{\sigma''}+1\}$ (1). When these three states are denoted by 0, 1, 0′, and when b_0, b_1, $b_{0'}$, are the corresponding probability amplitudes, the variation of these states with time can be written down as

$$i\hbar\dot{b}_0 = \sum_{\{n_s\}\sigma'} b_1 \langle 0|H'|1\rangle e^{\frac{it}{\hbar}(E_0-E_1)}; \qquad (2a)$$

$$i\hbar\dot{b}_1 = b_0\langle 1|H'|0\rangle e^{\frac{it}{\hbar}(E_1-E_0)} + \sum_{\{n_s'\}\sigma''} b_{0'}\langle 1|H'|0'\rangle e^{\frac{it}{\hbar}(E_1-E_{0'})}; \qquad (2b)$$

$$i\hbar\dot{b}_{0'} = \sum_{\{n_s\}} b_1 \langle 0'|H'|1\rangle e^{\frac{it}{\hbar}(E_{0'}-E_1)}; \qquad (2b)$$

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where H' is the energy operator of the interaction between gamma quanta and nuclei, E are the energies; $\vec{\kappa}_{\gamma}$ denotes the wave vector of the gamma quanta. The solution of system (2) has the form $b_0(t) = \exp\left\{-\Gamma t/2\hbar\right\}$ and $b_1(t) = C(n_s)\left[\exp\left\{-\Gamma t/2\hbar + \frac{it}{\hbar}(E_1 - E_0)\right\} - \exp\left\{-\Gamma t/2\hbar\right\}\right]$; $C(n_s) = \frac{\langle 1|H'|0\rangle}{E_0 - E_1 + i\frac{\gamma-\Gamma}{2}}$,

with the initial conditions $b_0(0) = 1$. The authors obtain the following expression for the probability of resonance scattering as dependent on the frequency of the incident and the scattered light and on the scattering angle:

$$W = \frac{M}{2\pi}\sum_{nn'jj'} e^{i\vec{\kappa}\Delta\mathbf{R}^0 - \alpha_j - \alpha_{j'}} \int_{-\infty}^{\infty} d\mu \int_{-\infty}^{\infty} dx \frac{e^{i\mu x}}{(\varepsilon_0 + x)^2 + \Gamma^2/4} \times$$

$$\times \int_0^{\infty} dt \int_0^{\infty} dt' \exp\left\{ie_1 t' - \frac{\gamma}{2}t' + K_j(t') + \sum_s \bar{n}_s d_s\right\} \exp\left\{-ie_1 t - \frac{\gamma}{2}t + \right.$$

$$\left. + K_{j'}(t) + \sum_s (\bar{n}_s + 1)\, d_s\right\}. \qquad (8)$$

$$G_j = \sum_s (\bar{n}_s + 1/2)\left(|P^s_{0-j}|^2 + |P^s_{0,j}|^2\right).$$

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$$K_j(t') = \sum_s P^s_{\sigma' j} P^s_{\sigma'' j} \{(\bar{n}_s + 1) e^{-i\hbar\omega_s t'} + \bar{n}_s e^{i\hbar\omega_s t'}\},$$

$$d_s = e^{i(\vec{f}\Delta\vec{R}^0 + i\hbar\omega_s)t} (P^s_{\sigma' j} - P^s_{\sigma'' j} e^{-i\hbar\omega_s t'}) (P^s_{\sigma' j'} - P^s_{\sigma'' j'} e^{i\hbar\omega_s t});$$

Notations: $M = (N_{\sigma''} + 1) N_{\sigma'} |L_{l_1 l_0}|^2 |L'_{l_1 l_0}|^2$; $\gamma = \frac{2\pi}{\hbar}(N_{\sigma''} + 1)\overline{|L_{l_1 l_0}|^2}\rho(E)$; $\rho(E) = \frac{E^2}{(2\pi c)^3 \hbar^2}$; the bar on top of the matrix element $|L|^2$ denotes integration over the solid angle and summation over the polarization of the scattered gamma quanta; $\Delta\vec{R}^0 = \vec{R}^0_{n'} - \vec{R}^0_n$; $\vec{R}_n$ indicates the coordinate of the n-th scattering nucleus; $\varepsilon''_0 = \hbar(\omega_{\sigma''} - \omega_{\sigma'})$; $\varepsilon_1 = -E + \hbar\omega_{\sigma''}$; $\vec{f}$ is the wave vector of the lattice vibrations, $\bar{n}_s = (\exp(\hbar\omega_s/kT) - 1)^{-1}$. $K_{j'}(t)$ is obtained by substituting -t and j' for t' and j in $K_j(t')$. $P^s_{\sigma j} = (\vec{p}_\sigma \vec{v}_j(s))/(2M_j N\hbar\omega_j)^{1/2}$; M_j denotes the mass of the scattering nucleus, $\vec{p}_\sigma$ the momentum of gamma quanta of frequency ω_σ, $\vec{v}_j(s)$ the displacement of the j-th atom in a cell with n = 0. The excitation spectrum is found to

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S/048/61/025/007/005/005
B108/B209

Resonance scattering of...

consist of a phonon part with a number of clear peaks and several Mössbauer lines of the half-width $\Gamma/2$. The structure of the scattering spectrum is analogous. N. N. Bogolyubov is thanked for discussions. There are 11 references: 3 Soviet-bloc and 8 non-Soviet-bloc.

ASSOCIATION: Institut fiziki Akademii nauk USSR (Institute of Physics of the Academy of Sciences UkrSSR)

Card 5/5

S/020/61/136/001/011/037
B019/B056

AUTHORS: Dzyub, I. P. and Lubchenko, A. F.

TITLE: The Theory of the Mössbauer Effect

PERIODICAL: Doklady Akademii nauk SSSR, 1961, Vol. 136, No. 1, pp. 66-69

TEXT: In connection with the studies of emission and the absorption of γ-quanta by nuclei in a crystal lattice, much interest is displayed in considering the changes in the equilibria and the oscillation frequencies in dependence on the nuclear state. Particular importance must be attached to the criteria which determine the absorption- and intensity curves and to the criteria concerning the existence of Mössbauer lines. It is these problems that the present paper deals with. A solid is investigated, in which γ-radioactive impurity nuclei are contained, and in which the interaction between the impurity atoms may be neglected. The binding between impurity atoms of the solvent is determined by the magnetic moment of the impurity atoms which depends on the nuclear state of the impurity atom. Using adiabatic methods, it was shown that the equilibrium of the atoms of the solvents and the frequency of the normal oscillations depend

on the state of the impurity nuclei. The authors give the wave function of the system nucleus + solvent + electromagnetic field in adiabatic approximation:

$$\Phi_{ln_sN\sigma} = \Psi_l |N_\sigma\rangle S_l |n_s\rangle \quad (1)$$

Ψ_l are the wave function of the nucleus and the electrons in the state l. $|n_s\rangle$ and $|N_\sigma\rangle$ are the wave functions of the lattice vibrations and of the emission field. The operator S_l^* gives different equilibria of the solvent nuclei for different nuclear states. In this case $S_l = \exp\left\{\sum_s \xi_{sl}(b_s^+ - b_s)\right\}$ (2) holds, where ξ_{sl} is the shift of the nuclear coordinates, b_s^+ and b_s are the phonon production- and annihilation operators. Proceeding from (1), the emission of γ-quanta by an impurity atom in the transition $l_1 \rightarrow l_o$ is investigated, and for the total emission cross section of the γ-quanta the relation $\sigma_e(E) = \frac{\Gamma^2}{4}\sigma_o W_e(E)$ (4)

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The Theory of the Mössbauer Effect

S/020/61/136/001/011/037
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is obtained, where

$$W_e(E) = \frac{2}{\Gamma} \mathrm{Re} \int_0^\infty \exp\left\{ i\mu (E - E_0') - \mu \frac{\Gamma}{2} + g_e(\mu) \right\} d\mu;$$

$$E_0' = E_0 + \sum_s \bar{n}_{sl_1} (\hbar\omega_{sl_1} - \hbar\omega_{sl_0});$$

$$g_e(\mu) = \sum_s |\xi_{sl_1} + i q_{sl_1}|^2 \{ (\bar{n}_{sl_1} + 1) e^{i\mu\hbar\omega_{sl_1}} + \bar{n}_{sl_1} e^{-i\mu\hbar\omega_{sl_1}} - 2\bar{n}_{sl_1} - 1 \};$$

Here, σ_0 is the total resonance absorption cross section for γ-quanta by a free nucleus, E_0 is the energy difference between the excited and the ground state of the impurity atoms in consideration of its interaction with electrons and the solvent. The calculation of $W_e(E)$ for high and low temperatures is dealt with in great detail. From the analysis of the results obtained, the authors conclude that in consideration of the changes in the equilibrium of the nuclei and the normal frequencies of the lattice, the Mössbauer lines shift with the temperature by the quantity $\Delta E = \sum_s \bar{n}_{sl_0} (\hbar\omega_{sl_1} - \hbar\omega_{sl_0})$. The absorption- and emission maxima are at a

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S/020/61/136/001/011/037
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distance from the Mössbauer lines, which corresponds to the recoil energy of the nucleus. The authors thank N. N. Bogolyubov and M. V. Pasechnik for discussions and for their interest. There are 9 references: 1 Soviet, 2 German, and 6 US.

ASSOCIATION: Institut fiziki Akademii nauk USSR (Institute of Physics of the Academy of Sciences of the UkrSSR)

PRESENTED: July 22, 1960, by N. N. Bogolyubov, Academician

SUBMITTED: July 6, 1960

Card 4/4

DZYUB, I.P.; LUBCHENKO, A.F.

Emission and absorption of gamma-quanta by nuclei of solids in the presence of time-dependent external perturbation. Fiz. tver. tela 4 no.8:2081-2089 Ag '62. (MIRA 15:11)

1. Institut fiziki AN UkrSSR, Kiyev.
(Gamma rays) (Quantum theory)

37872
S/185/62/007/005/001/013
D407/D301

24.6410

AUTHORS: Dzyub, I.P., Lubchenko, A.F., and Ch'in Yün-weng

TITLE: Resonance scattering of gamma rays by impurity atoms in solids

PERICDICAL: Ukrayins'kyy fizychnyy zhurnal, v. 7, no. 5, 1962, 457 - 468

TEXT: The authors calculated the excitation and scattering spectra of gamma rays by impurity nuclei, allowance being made for changes in the frequency of normal-mode oscillations of the solid solution, and in the equilibrium positions of the impurity atoms in the case of large as well as small heat-release. It is assumed that the impurity concentration is low, so that the interaction between the impurity atoms can be neglected. In the adiabatic approximation, the wave functions and the corresponding energy values of the system are:

$$\Phi_{l\{n_s\}\{N_\sigma\}} = \psi_l |N_\sigma\rangle \hat{S}_l |n_s\rangle, \quad (1)$$

$$E_{l\{n_s\}\{N_\sigma\}} = E_l + E_{\{N_\sigma\}} + V_l^l(R_0) + \sum_s \hbar\omega_s^l \left(n_s + \frac{1}{2}\right) - \sum_s \hbar\omega_s^l \xi_{sll}^2, \quad (2)$$

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where E_l is the internal energy of the impurity atom; $E_{(N_\sigma)}$ - the energy of the radiation field; $V_l^i(R_o)$ - the potential energy of the solid solution; ω_s^l - the frequency of the s-th normal mode; ξ_{sl} - the displacement of the atoms from the equilibrium position. An integral formula is obtained for the probability W of resonance scattering. The excitation and scattering spectra are calculated under the following assumptions: a) The spectrum of the incident gamma rays is constant in the phonon part of the absorption spectrum; b) the energy of the gamma rays is much higher than the width of the phonon part. Formulas are obtained for the excitation- and scattering spectra. It is concluded that 1) Under assumptions (a) and (b), the excitation spectrum coincides with the absorption spectrum of gamma rays. With large heat-release, the shape of the phonon part of the spectrum is close to a Gaussian curve, with a strong line of natural width (Mössbauer's line) on its longwave wing; the intensity of this line decreases fast with increasing temperature. With small heat-release, the excitation spectrum is the sum of Lorentz curves. The position of the entire spectrum changes with temperatu-

re. 2) The scattering spectrum does not generally coincide with the radiation spectrum, (under assumptions (a) and (b)). With large heat-release, the scattering spectrum coincides only at the wings with the radiation spectrum or if the viewing angle is 90°; Mössbauer's line is towards the shortwave side from the maximum of the phonon part. With small heat-release, the scattering spectrum differs little from the radiation spectrum: Mössbauer's line is present, whose intensity varies with temperature (as in the case of the excitation spectrum). If the spectrum of the incident gamma-rays has the shape of a Lorentz curve with maximum at the point $\hbar\Omega_0$ and half-width γ_0, then it is impossible to determine the scattering spectrum in the general case: Therefore the authors derived a formula for "soft" gamma-rays only (with energies of several kev.). The first term of this formula represents Mössbauer's line, whereas the other terms represent inelastic scattering of gamma-rays which is accompanied by phonon creation or annihilation. There is 1 figure and 7 references: 4 Soviet-bloc and 3 non-Soviet-bloc (including 1 translation).

Card 3/3 Inst Physics AS UKR SSR

S/020/62/145/001/010/018
B104/B102

AUTH: Dzyub, I. P., and Lubchenko, A. F.

TITLE: Effect of forced crystal vibrations on the spectrum of scattered γ quanta

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 145, no. 1, 1962, 73-75

TEXT: The single-phonon peaks in the spectrum of scattered γ quanta can be considerably intensified by forced crystal vibrations imparted e.g. by a quartz ultrasonic resonator. A study of the Rayleigh diffusion reveals the following: when a γ radiation with narrow energy band containing Mössbauer lines impinges on the scatterer, a Mössbauer line is observed only under a Bragg angle determinable from the conditions $\omega_\lambda - \omega_{\lambda'} = 0$ and $\vec{k}_{\lambda'} - \vec{k}_\lambda = \vec{K}$, where ω_λ is the frequency of the Mössbauer quanta and $\omega_{\lambda'}$ is the scattered-light frequency. Observations made at another angle ($\vec{k}_{\lambda'} - \vec{k}_\lambda - m\vec{q} = \vec{K}$) showed narrow bands $\omega_{\lambda'} = \omega_\lambda \pm m\omega_q$ in the spectrum of the γ quanta. ω_q is the lattice vibration frequency. The ratio between

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Effect of forced crystal vibrations...

relative line intensities of scattered γ quanta is $2\pi|\vec{a}|/d$ where d is the lattice constant and $\vec{a}$ the amplitude of the lattice vibrations. Academician N. N. Bogolyubov is thanked for discussions. There is 1 figure.

ASSOCIATION: Institut fiziki Akademii nauk USSR (Institute of Physics of the Academy of Sciences UkrSSR)

PRESENTED: February 19, 1962, by N. N. Bogolyubov, Academician

SUBMITTED: February 10, 1962

Card 2/2

DZYUB, I.P.; LUBCHENKO, A.F.

Mössbauer effect on impurity nuclei at low temperatures. Dokl. AN SSSR 147 no.3:584-587 N '62. (MIRA 15:12)

1. Institut fiziki AN UkrSSR. Predstavleno akademikom N.N. Bogolyubovym.

(Mössbauer effect)

L 10228-63 EWT(1)/BDS/EEC(b)-2--AFFTC/ASD

ACCESSION NR: AP3000044 S/0056/63/044/005/1518/1524

56
54

AUTHOR: Dzyub, I. P.; Lubchenko, A. F.

TITLE: The method of temperature Green's functions in the theory of the Mossbauer effect on impurity nuclei

SOURCE: Zhurnal eksper. i teoret. fiziki, v. 44, no. 5, 1963, 1518-1524

TOPIC TAGS: Mossbauer effect, probability, temperature shift, temperature Green's functions

ABSTRACT: The probability of the Mossbauer effect for an impurity nucleus in solid solution and the temperature shift of the Mossbauer line are determined by the method of temperature Green's functions. The study of the Mossbauer effect for impurity nuclei in solid solution is of interest because it offers some pobssibility of changing the intensity of the Mossbauer line from a single radioactive nucleus by suitable choice of the crystal-solvent. The method of temperature Green's functions obviates the need for solving the dynamic problem for a substitutional solution. General equations are obtained for the

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ACCESSION NR: AP3000044

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probability of the Mossbauer effect and for the temperature shift of the line in terms of the parameters of the ideal solvent lattice and the mass ratio of the impurity and crystal-solvent atoms, as well as quantities characterizing the interaction of the impurity atom and the atoms of the solvent. Specific computations are made for a monatomic cubic crystal-solvent in the Debye approximation. The computed values of the probability and of the temperature shift are compared with the available experimental data. "We thank N. N. Bogolyubov for valuable comments and his interest in the work." Orig. art. has: 2 figures and 23 formulas.

ASSOCIATION: Institut fiziki Akademii nauk Ukrainskoy SSR (Institute of Physics, Academy of Sciences USSR)

SUBMITTED: 14Jul62 DATE ACQ: 12Jun63 ENCL: 00

SUB CODE: PH NR REF SOV: 006 OTHER: 008

Card 2/2

L 33596-66 EWT(1) IJP(c) WW/GG

ACC NR: AR6016204 SOURCE CODE: UR/0058/65/000/011/D036/D036

AUTHORS: Lubchenko, A. F.; Pavlik, V. M.

TITLE: Raman and Rayleigh scattering of light by impurity centers of a solid

SOURCE: Ref. zh. Fizika, Abs. 11D279

REF SOURCE: Tr. Komis. po spektroskopii. AN SSSR, t. 3, vyp. 1, 1964, 405-411

TOPIC TAGS: Raman scattering, Rayleigh scattering, impurity center, solid solution, absorption band, Raman spectrum

ABSTRACT: A theory of Raman and Rayleigh scattering of light by solid solutions of low concentration is developed. It is shown that in the case of phototransitions accompanied by small heat release the scattering spectrum comprises a system of bands with a clearly pronounced series of peaks. The integral scattering intensity increases sharply as the frequency of the scattered light approaches the region of impurity absorption, this being in agreement with the experimental results obtained by Shorygin. [Translation of abstract]

SUB CODE: 20

Card 1/1

L 18006-63 EWT(1)/FCC(w)/BDS/EEC(b)-2 AFFTC/ASD/ESD-3/IJP(C)/SSD
Pi-4 GG

ACCESSION NR: AP3001296 S/0181/63/005/006/1714/1723

AUTHORS: Lubchenko, A. F.; Pavlik, B. M.

TITLE: Combination and Rayleigh scattering of light by impurity centers in solids

SOURCE: Fizika tverdogo tela, v. 5, no. 6, 1963, 1714-1723

TOPIC TAGS: combination scattering, Rayleigh scattering, impurity center, scattering spectrum, absorption, frequency, absorption coefficient

ABSTRACT: The authors have developed a theory of combination and Rayleigh scattering at impurity centers in solids. They computed the shapes of the excitation and scattering spectra and determined the dependence of integral intensity of the combination-scattering band on the frequency of the exciting light. They have shown that in the case of photoelectric transitions accompanied by small emissions of heat the scattering spectrum is a system of bands with a well-defined series of peaks, one of which corresponds to the normal scattering line. The others form a low-frequency spectrum--Rayleigh "wings" of the scattering spectrum. In the region of light absorption by

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ACCESSION NR: AP3001296

impurity centers, the integral intensity of each band is very quickly computed by $(\nu-\Omega_{lo})4t^2(\nu)$, where ν is the frequency of the exciting light, Ω_{lo} is the frequency of the corresponding intramolecular vibration, and $t(\nu)$ is the coefficient of light absorption. "In conclusion the authors express their thanks to A. S. Davy*dov for his valuable discussions and for his interest in the work." Orig. art. has: 16 formulas.

ASSOCIATION: Institut fiziki AN USSR, Kiev (Institute of Physics, Academy of Sciences, Ukrainian SSR)

SUBMITTED: 22Dec62 DATE ACQ: 01Jul63 ENCL: 00

SUB CODE: PH NO REF SOV: 018 OTHER: 004

Card 2/2

L 13276-65 EWT(1)/EEC(b)-2 IJP(c)/AFWL/BSD/RAEM(i)/ESD(gs)

ACCESSION NR: AP4046695 G/0030/64/007/001/0105/0119

AUTHORS: Lubchenko, A. F.; Pavlik, B. M. 8

TITLE: The Green's function method in the theory of light absorption by impurity centers of a solid

SOURCE: Physica status solidi, v. 7, no. 1, 1964, 105--119

TOPIC TAGS: Green function, light absorption, impurity center, anharmonicity, solid solution, phototransition

ABSTRACT: This is an extension of earlier work by one of the authors (Lubchenko, phys. stat. sol. v. 6, 319, 1964), in which the effect of anharmonicity of the solid-solution-atom vibrations on the form of the spectra of emission and absorption of light by impurity centers contained in the solid solution was investigated. The present article deals with absorption of light by impurity centers with account of anharmonicity in both the initial and final electronic

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states of the impurity, whereas in the earlier work the temperature of the solution was assumed to be sufficiently low that only the role of the state in which the phototransition is effected was taken into account. The Green's function method is used and in calculating the change in the frequencies of the normal oscillations and the level widths due to the anharmonicity, the difference in the anharmonic terms in the initial and final electronic states of the impurity center is neglected. The shape of the phonon part of the spectrum and of the phononless line are calculated, their variation with temperature and with the nature of the solvent is investigated, and it is shown that the distance between the maxima of the overtones of the same frequency, in the case of impurity centers with internal vibrational degrees of freedom, decreases with increasing number of the overtone and is a function of the temperature. The phononless line has in the case of impurity centers a quasi-Lorentz shape with a half width greatly dependent on the temperature and practically coinciding with the Lorentz shape in the region of the maximum. In

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this respect it differs from a Mossbauer line. Some of the reasons for the difference are discussed. Orig. art. has: 1 figure and 30 formulas.

ASSOCIATION: Institut fiziki Akademii nauk Ukrainskoy SSR, Kiev (Institute of Physics, Academy of Sciences UkrSSR)

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ACCESSION NR: AP5000627 S/0185/64/009/011/1221/1232

AUTHOR: Lubchenko, A. F.; Pavlyk, B. M. (Pavlik, B. M.)

TITLE: Mirror symmetry in the light absorption and emission spectra of impurity centers in solids

SOURCE: Ukrayins'ky*y fizy*chny*y zhurnal, v. 9, no. 11, 1964, 1221-1232

TOPIC TAGS: emission spectrum, absorption spectrum, impurity center, mirror symmetry, electron vibration band, spectral band

ABSTRACT: The numerous studies of absorption and emission spectra in the visible range of the impurity centers in solids indicate that the mirror symmetry, established empirically by V. L. L'ovshin in 1931, in many cases does not hold, not only for impurity molecules but also for the case of impurities without internal vibrational degrees of freedom (atoms, ions, color centers). It is shown in this work that during harmonic approximation for atomic vibrations in solid solutions, taking into account the dependence of the quasielastic constants on the electronic state of the impurity does not lead to violation of mirror symmetry for the case of impurities without internal vibrational degrees of freedom. In the case of impurity centers with internal vibrational degrees of freedom, electron vibrational emission and absorption bands will not have mirror symmetry with respect to the

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position of the maxima, if the frequencies of the internal degrees of freedom are different in the ground and excited states. In this case, the half-widths of the emission and absorption bands are the same and the genesis of the bands during changes in temperature proceeds in the same fashion. Orig. art. has: 41 formulas.

ASSOCIATION: Instytut fizyky AN URSR, Kiev (Physics Institute, AN URSR)

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ACCESSION NR: AP5018634 UR/0185/65/010/007/0734/0744

AUTHORS: Lubchenko, A. F.; Pavlyk, B. M. (Pavlik, B. M.)

TITLE: Absorption and emission of light by impurity centers of a solid with allowance for anharmonicity

SOURCE: Ukrayinsk'yy fizychnyy zhurnal, v. 10, no. 7, 1965, 734-744

TOPIC TAGS: light absorption, light emission, impurity center, line spectrum, line width

ABSTRACT: The absorption and emission of light by impurity centers of a solid are being considered with allowance for anharmonicity both in the initial and final electron states. The calculations are carried out by the method of Green's functions with account of the dependence of the frequencies of the normal oscillations of the atoms on the electronic state of the impurity. The shape of the phonon part of the spectrum and that of the phononless line is calculated as a function of the temperature and the nature of the matrix. It is found that the phonon part of the absorption spectrum has the form of

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